# Space Weather Technical Forecast

Issued on Monday 9 December 2024 at 00:43 Local

**This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

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**Space Weather Forecast Headline: M-class flares likely with a slight chance of isolated X-class Flares and Solar Radiation storms.**

**Analysis of Space Weather Activity over past 24 hours**

**Solar Activity:** High activity with an X2.2 flare at 08/0906 UTC from AR3912 in the southwest. There are currently eight sunspot regions on the disc. AR3917 may be the most magnetically complex, with the potential for a delta spot in the leading group, although this is uncertain due to the lack of high resolution imagery. AR3912 also has the potential for a delta spot, although again this is uncertain, particularly as it is starting its approach towards the limb. Given the recent X-flare from this region however, it must be considered an ongoing flare risk. AR3916 appears fairly small and straightforward, but AR3919 which has developed nearby, whilst small, appears to have a slightly complex magnetic layout. AR3916, AR3917 and AR3919 are all in close proximity to each other, increasing the likelihood of interaction between them. Other regions appear small and simple at the present time.

Following on from the X2.2 flare on the 08 Dec, analysis suggests that the resulting CME is likely to pass ahead of Earth's orbit, with no or limited impacts at Earth. No other Earth directed CMEs were seen in the last 24 hours.

**Solar Wind / Geomagnetic Activity:** Solar winds, as recorded at L1 by ACE, showed signs of a weak HSS. Wind speeds increased from background levels, around 370 km/s, to slightly elevated near 440 km/s. Density has been average or below. The Interplanetary Magnetic Field (Bt) has been largely moderate at 10nT or below. The north-south component (Bz) fluctuated weakly for much of the period, becoming moderately variable after 08/2300 UTC. The phi angle was positive (away from the Sun) throughout. Quiet geomagnetic activity throughout.

**Energetic Particles / Solar Radiation:** High energy proton flux observed by GOES18 was at background levels. High energy electron flux (greater than 2MeV) observed by GOES16 was at background levels.

The associated 24-hour fluence was below Active, and the 09/0000 UTC observation was 1.34e6 integrated pfu.

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# Space Weather Technical Forecast

**Four-Day Space Weather Forecast Summary**

**Solar Activity:** Further M-class flares are likely, with a slight chance of isolated X-class flares, this risk decreasing slightly after AR3912 rotates off the disc.

**Solar Wind / Geomagnetic Activity:** No Earth directed CMEs are currently expected. Wind speeds are likely to be slightly elevated for much of this period, mainly due to CH98/+. Geomagnetic activity is expected to be subdued given the proximity to the Solstice.

As a result, Quiet to Unsettled geomagnetic conditions are expected with a slight chance of Active intervals if the Bz has extended negative periods.

**Energetic Particles / Solar Radiation:** There is a slight chance of high energy protons reaching the S1/Minor Radiation Storm threshold, mainly due to AR3912.

High energy electron flux is expected to be at background or perhaps moderate levels, but the 24-hour fluence is likely to remain below the Active threshold.

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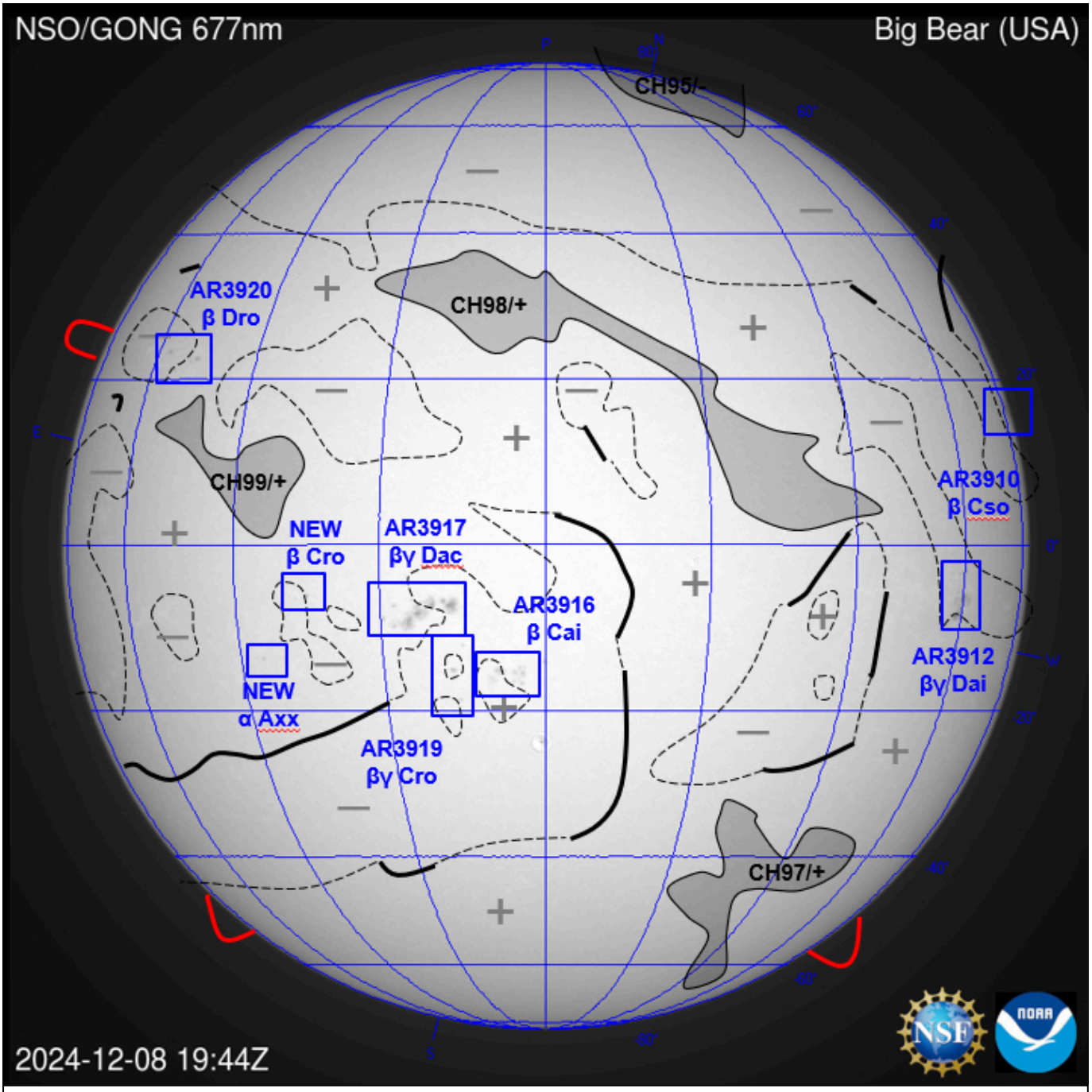
**Figure 1: Solar synoptic map, valid 08/2000 UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms

Following on from the X2.2 flare at 08/0906 UTC, analysis suggests that the resulting CME is likely to pass ahead of Earth's orbit, with no or limited impacts at Earth.

The current solar wind parameters at L1 suggest a weak HSS connection, either to the northern edge of CH97/+, or the onset of CH98/+. In either event, based on the previous rotation where the coronal holes were fairly similar, wind speeds are not expected to increase much above 450km/s. Despite this connection to the HSS, geomagnetic activity is still expected to be subdued given the time of year (near the semi-annual minimum geoeffectivity of coronal holes of any polarity around the Solstices). Wind speeds are therefore likely to be slightly elevated for much of this period, given the longitudinal extent of CH98.

As a result, Quiet to Unsettled geomagnetic conditions are expected with a slight chance of Active intervals if the Bz has extended negative periods.

| Geomagnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 1 | 1 | 1 | 1 |
| Strong | G3 | No | 1 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

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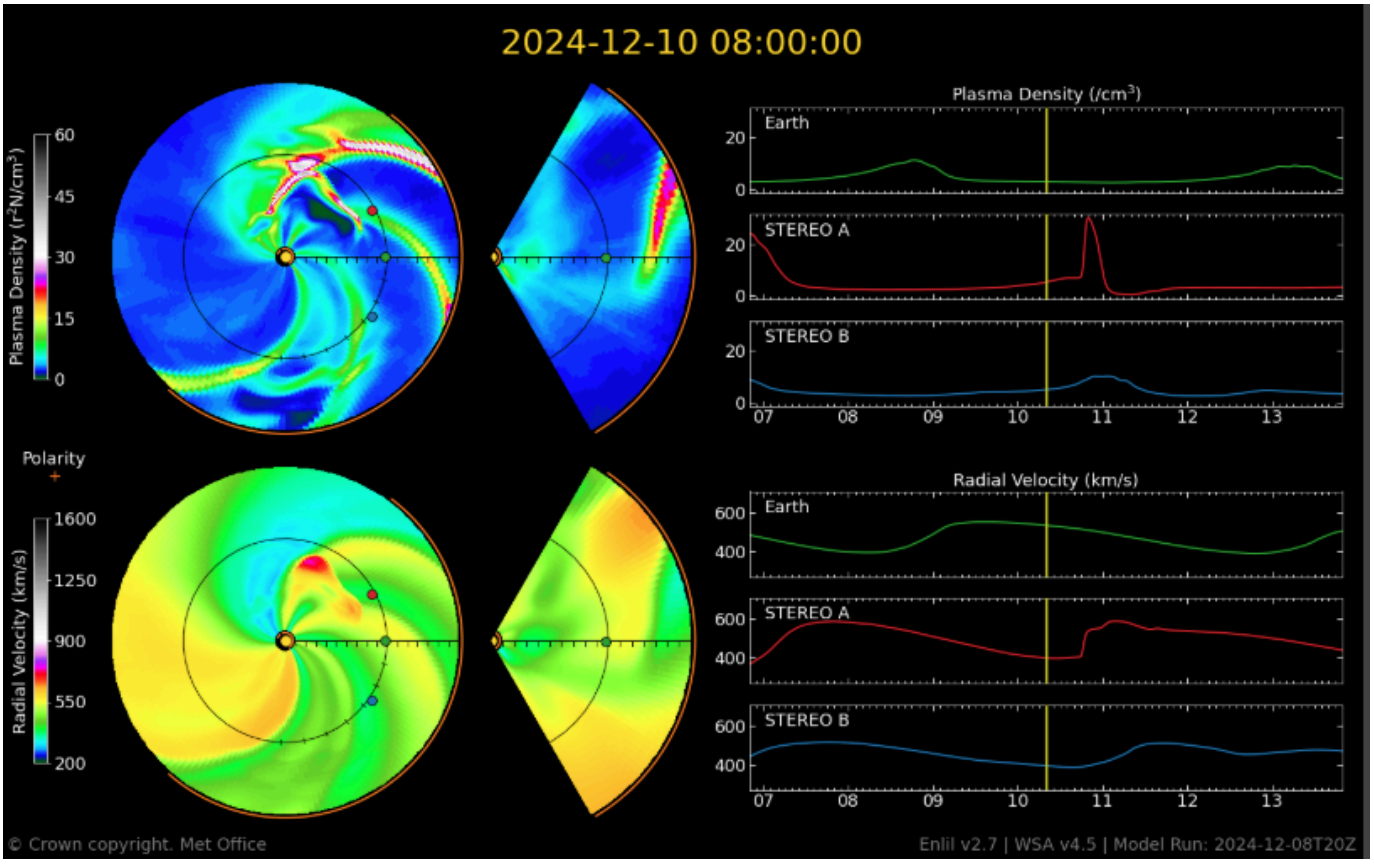
**Figure 2: MOSWOC Enlil, with the CME from the X2.2 flare passing ahead of Earth's orbit.**



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## Radio Blackouts - X-Ray Flares

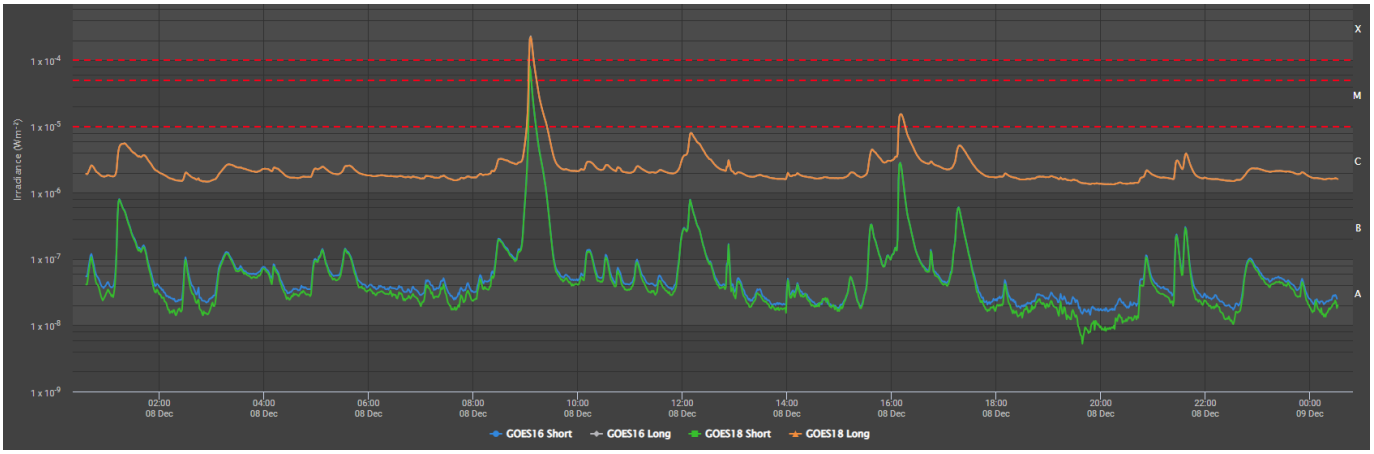
There are currently eight sunspot regions on the disc, including two newly numbered regions - AR3919 just east of AR3916 and AR3920 in the northeast. AR3917 may be the most magnetically complex, with the potential for a delta spot in the leading group, although this is uncertain due to the lack of high resolution imagery. AR3912 also has the potential for a delta spot, although again this is uncertain, particularly as it is starting its approach towards the limb. Given the recent X-flare from this region however, it must be considered an ongoing flare risk. AR3916 appears fairly small and straightforward, but AR3919 which has developed nearby, whilst small, appears to have a slightly complex magnetic layout. AR3916, AR3917 and AR3919 are all in close proximity to each other, increasing the likelihood of interaction between them. Other regions appear small and simple at the present time.

In terms of oncoming regions, Ex-AR3893 is due over the southeastern solar horizon inside the next 24 hours - this group produced M-class flares on its last pass. Some looping on the southeast limb suggests the potential for a new region to rotate on in this location, although far side soundings do not detect any significant regions in this location. For departing regions, AR3912, which was responsible for the recent X-flare, will rotate off at the end of Day 2 (10 Dec), with the flare risk reducing during the following 24 hours.

Overall, M-flares are considered likely, with a slight chance of an X-flare, this reducing a little later in the period as AR3912 rotates off.

| X-Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 (M Class) | Yes | 60 | 60 | 60 | 50 |
| Very Active | R3-R5 (X Class) | Yes | 10 | 10 | 10 | 5 |

**Figure 3: X-ray flux at GOES16 and 18, showing the X2.2 flare on 08 December.**

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## Solar Radiation Storms (High Energy Protons)

GOES18 proton flux is currently at background levels. The earlier X2.2 flare from AR3912 did not produce a response in the high energy protons, although low energy protons did show a slight rise. Should this region produce another larger flare, then there is a slight chance of a high energy proton response, and this risk remains until AR3912 is well over the limb. Remaining regions on the disc do also contribute a little to this risk, especially as the AR3916/AR3919/AR3917 complex rotates into the eastern hemisphere.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}sr^{-1}s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 10 | 10 | 10 | 10 |
| **Very Active** | **≥ S3 *** | No | 1 | 1 | 1 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

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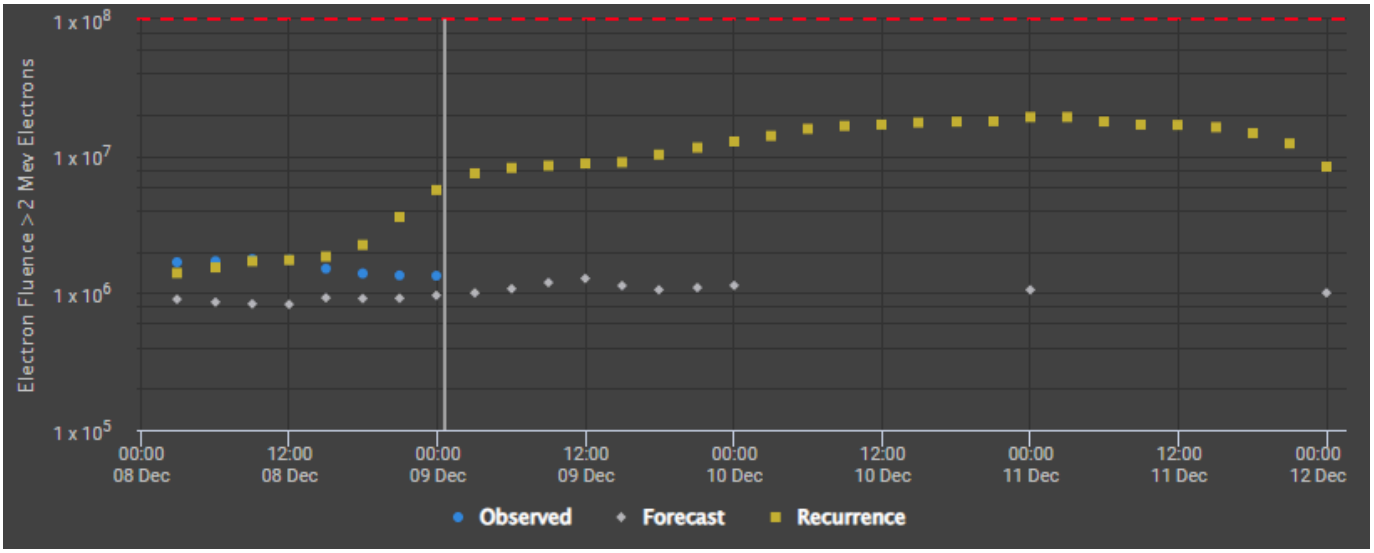
## High Energy Electrons (≥ 2MeV)

High energy Electron flux observed by GOES16 has been at background levels. The current HSS is very weak, and wind speeds are unlikely to rise much above 450 km/s during this period. As such, any response in electron flux later in the period is likely to be muted, with electron flux perhaps reaching moderate levels at the diurnal maxima and just a slight chance of reaching high levels.

The associated 24-hour fluence is expected to remain below the Active threshold, although a slight increase may occur later in the period. MOSWOC REFM is currently showing a flat trend through the next 3 days, which is the most likely outcome.

| GEO Electron Environment | Level ($cm^{-2}sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability (Exceedance) | | | (%) | (%) | (%) | (%) |
| Active | ≥ 2 MeV ≥ $1\times10^{8}$ | No | 1 | 5 | 5 | 10 |
| Very Active | ≥ 2 MeV ≥ $1\times10^{9}$ | No | 1 | 1 | 1 | 1 |

**Figure 4: MOSWOC REFM showing a flat trend through the next three days, which is the most likely outcome.**

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